FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE MEETING
Crystal City, Virginia
May 30, 2001

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ACTION ITEMS

The following action items were identified during this meeting of the Federal Remediation Technologies Roundtable:

- Submit comments within 30 days on the draft fact sheet: *Federal Remediation Technologies Roundtable: Creating Tools for the Hazardous Waste Cleanup Community* to Naomie Smith at TIO (in welcoming remarks).
- Hold a one-hour meeting after a Roundtable meeting with SES-level people to discuss policy implications of issues at hand (page 5).
- Identify new projects for inclusion in the next update of the Cost and Performance Report (page 6).
- Update the FRTR screening matrix and produce a third edition (page 7).

The technical topic for the fall 2001 meeting of the Federal Remediation Technologies Roundtable will be optimization of treatment systems. The AFCEE will chair the meeting and coordinate speakers.

WELCOME/OPENING REMARKS

Walt Kovalick, U.S. EPA/TIO, welcomed the attendees and opened the meeting of the Federal Remediation Technologies Roundtable (FRTR). Mr. Kovalick asked participants to review a draft fact sheet, *Federal Remediation Technologies Roundtable: Creating Tools for the Hazardous Waste Cleanup Community*, and submit comments within 30 days to Naomie Smith, TIO. Also in the meeting packet was a flyer announcing new products from TIO. After asking those in attendance to introduce themselves, Mr. Kovalick introduced the chairperson for the meeting, Olga Dominguez, Director of the Environmental Management Division at NASA.

Chairperson's Remarks

Ms. Dominguez said the Roundtable is important because it shows how federal agencies can work together to share information and data, especially when new problems like perchlorate arise. NASA has one site that has an identified perchlorate problem. Their major issue in dealing with perchlorate is what are the cleanup levels going to be. She hoped that the discussion today would eventually lead to a template on how to deal with finding a new chemical. For NASA, perchlorate was suddenly a chemical of concern in a plume they had been studying for 10 years. How do you convey to the public that you have control of both the old problem and this new one?

PERCHLORATE OVERVIEW & ACTIVITIES

Overview of the Perchlorate Problem

Kevin Mayer, EPA Region 9, talked about the chemistry, toxicology, and occurrence of perchlorate (ClO_4), a highly oxidized disassociated chlorine salt. It is typically paired with ammonium, potassium or sodium. Perchlorate salts are highly soluble, mobile, stable, and difficult to treat. Perchlorate was difficult to detect before 1997, when an ion chromatography technique was developed to bring the detection limit down to about 4 µg/l. Important to its toxicological mechanism of action, the size of the perchlorate ion is close to iodide.

Before 1997, EPA Region 9 had an idea that perchlorate was used in large amounts at some sites that were being considered for the NPL, but not much was known about its fate and transport. In the mid-1980s, Region 9 had many perchlorate detections at a San Gabriel Valley Superfund site, but the

analytical method was suspect. In the 1990s at the Rancho Cordova (Aerojet) site, perchlorate was detected at levels that made it clear the substance was in the water. In 1985, EPA asked the Agency for Toxic Substances and Disease Registry (ATSDR) for advice on perchlorate. ATSDR said the analytical method was too suspect to conclude that perchlorate was present, and that the current science was insufficient to set a risk level.

EPA also found that perchlorate use is widespread: manufacturers reported shipments to most states. Perchlorate releases have been detected in 18 states, mostly in the southwest and northeast. However, he noted that most states do not test for perchlorate, so the actual incidence may be much higher.

Mr. Mayer said EPA Region 9 has 21 sites with known perchlorate contamination and 187 water supply wells with measurable perchlorate levels. Nevada has one of the largest problems, with a site releasing over 800 pounds per day into Lake Mead. This has contaminated the lower Colorado River, which is a drinking water source for Las Vegas, Phoenix, Tucson, Los Angeles, and San Diego. Lake Mead itself puts about 1,000 pounds of perchlorate per day into the Colorado River.

Perchlorate is a thyroid disruptor, and has been used in the past to treat hyperactive thyroids. The 1950s study EPA used to set provisional reference doses was a pharmacological rather than a toxicological study. It did not address chronic effects or effects on children, nor did it establish a no-observable-effect dose. They found that perchlorate at 100 mg/day will shut down the thyroid, and that effects begin with a dose of 10 mg/day. EPA used this study in 1992 to establish a provisional reference dose (RfD) for a 70 kg adult drinking two liters a day, which translated into a concentration of 4 µg/l in drinking water. In 1995, after much discussion of the uncertainty factors used to reach the 4 µg/l concentration, the recommendation was changed to a range of 4-18 µg/l.

The Department of Defense and industry have been doing a considerable amount of toxicological work on perchlorate in recent years and supplying this data to EPA scientists. The emphasis is on cancer and non-cancer effects and mechanisms of action in the body. Studies have found changes in the thyroids of newborn lab animals, which leads to concerns about permanent neuro-developmental effects in children. He said there has been significant interagency cooperation and industry input to make the test designs and results satisfactory to all in the shortest possible time frame. Results are expected in June 2001, and a second EPA peer review (IRIS) is expected this fall.

Mr. Mayer said that perchlorate currently is not a federally regulated chemical. However, EPA's Office of Research and Development (ORD) recommends using the original RfD for perchlorate until better numbers can be developed. This translates into drinking water concentrations in the 4-18 µg/l range. Mr. Mayer said he is aware of only four states that have action levels for perchlorate. They are California and New York at 18 µg/l, Texas at 22 µg/l, and Arizona at 14 µg/l. Texas and Arizona developed their action levels using child exposure models.

Cleanup goals for perchlorate at Superfund sites in Region 9 have been set at the detection limit of the analytical method (4 µg/l). Mr. Mayer said there are concerns about uptake by agricultural vegetables irrigated with contaminated water from the Colorado River. There are also concerns about the direct effects of high concentrations of perchlorate on fish and animals, especially because the developmental effects of perchlorate are unknown. A participant asked why EPA has adopted an action level of 4 µg/l for two Superfund sites, given that state action levels are so much higher. Mr. Mayer explained that the action levels were set in response to community concerns, health uncertainties, and other factors. He noted that the treatment technology is not precise enough to treat to a specific concentration level, so treatment to achieve somewhat higher state standards often is no different than treating to the 4 µg/l or non-detect level.

Inter-Agency Perchlorate Steering Committee (IPSC) Activities

Federal Remediation Technologies Roundtable Meeting, Crystal City, Virginia, May 30, 2001

Lt. Colonel Dan Rogers, U.S. Air Force and member of the Executive Committee of the Interagency Perchlorate Steering Committee (IPSC), updated the Roundtable on the Perchlorate Partnering Project. He stated that perchlorate is the primary oxidizer in solid rocket fuels and is used by the military in missiles and by NASA in the space shuttle. Solid rocket fuel systems are superior to other systems and are vital to defense activities. Lt. Col. Rogers said that the military is addressing perchlorate problems resulting from past rather than current practices, including open burn and open detonation sites. Perchlorates have also been found in other non-military uses such as medicine, explosives (including fireworks), flares, fertilizer, and ammunition. Because perchlorate was an environmental surprise, the challenge is to develop credible science to support credible decisions in a short period of time. The science has to be present to provide accurate risk characterization and to enable the development of appropriate management strategies.

The purpose of the Perchlorate Partnering Project was to bring together the leading experts working on perchlorate issues to determine what was known and identify research needs so that funding can be directed at filling information gaps. The group also acts as a clearinghouse to provide the public with real-time information on perchlorate projects and for considering public concerns.

The IPSC was formed in January 1998 to accomplish these goals. The group includes federal, state, and tribal representatives. The IPSC has an executive committee and six subcommittees (health effects/toxicity, communications, ecological impacts, analytical, peer review, and treatment technology). Experts meeting in Cincinnati identified eight studies needed to fill information gaps. These studies were performed in 1998. They reinforced the idea that the thyroid was the primary target of perchlorate in humans. An external peer review conducted by EPA in February 1999 recommended 16 additional studies in toxicology and ecosystem impact. The IPSC also held stakeholder meetings, at which they presented their understanding of the perchlorate problem.

EPA plans to conduct an external peer review of data from the 16 toxicity and ecosystem impact and occurrence studies this fall. While perchlorate can be detected at 4 µg/l and below in water, blood, urine and tissue, current analytical methods do not permit detection at this level in citrus products, fruits, milk, and soy products. These latter are critical because of the need to determine if uptake is occurring in Southern California livestock and crops irrigated with perchlorate-contaminated water. The farm uptake analysis will not be completed in time for the fall peer review.

Ground Water Remediation Technologies Analysis Center (GWRTAC) Perchlorate Report

Diane Roote, Ground Water Remediation Technologies Analysis Center (GWRTAC), gave an update on GWRTAC's perchlorate treatment technologies report. The study was funded last fall by DoD and provides a snapshot in time of perchlorate treatment technologies. It is available on their website at: http://www.gwrtac.org.

The study was designed to:

- Compile completed, in-progress, and planned perchlorate treatment technology projects and R&D efforts from laboratory, to pilot, to full scale;
- Provide a one-stop overview of DoD and non-DoD projects and R&D efforts with brief project summaries; and
- Organize information into a database format to assist in analyzing trends.

To date, there are 65 project summaries, 36 of which are primarily R&D efforts and 29 of which are pilot-to commercial-scale projects that investigate feasibility or have a remediation objective. The treatment technologies fall into five broad categories: (1) Physical Processes (ex situ); (2)Chemical Processes (ex situ); (3) Biological Processes (ex situ anaerobic or anoxic); (4) In-Situ Bioremediation; and (5) Phytoremediation. About half of the projects are in progress, and four are full-scale completions. Fifty-four of the projects are targeted at ground water or wastewater treatment. They are being conducted

primarily in EPA Regions 6 and 9. Forty-five of the projects use some form of biological treatment, and most are bioreactors. Twenty projects use some form of physical/chemical treatment, with ion exchange being the dominant type. GWRTAC was unable to identify the concentration range being treated for 25 of the projects, but of the remaining 40, 15 were treating concentrations less than 1,000 µg/l, and only two were treating concentrations greater than 1,000 mg/l. No physical technologies were identified for treating high concentrations of perchlorate.

Research and development efforts were focused on:
- Selective removal of perchlorate by ion exchange resins to avoid unnecessary removal of other ions;
- Regeneration or disposal of ion exchange media;
- Treatment and disposal or reuse of brines (physical techniques);
- The search for stable, non-toxic reducing agents or catalysts for chemical reduction;
- Enzyme isolation from microbes to develop selective biological removal processes;
- Better understanding of perchlorate reducing microbes (PRM) physiology; and
- Development of in situ biological methods.

The R&D efforts were being supported largely by funding through the American Water Works Association Research Foundation, SERDP/ESTCP, National Science Foundation, the individual services, NASA, and DOE. Several water districts and PRPs are also involved.

Roundtable Agencies Perspectives/Issues
Walt Kovalick asked FRTR members to discuss their agency perspectives on the perchlorate problem.

NASA: Olga Dominguez said that NASA's current perchlorate issues are in California. Cleanup levels for perchlorate are a moving target: California's cleanup level is 18 µg/l, while EPA uses 4 µg/l. The cleanup levels are also related to the facility location since ground water in their basin is an indispensable source of drinking water. As a result, there are issues related to getting permission to extract and treat the water as well as what to do with it after treatment.

NAVY: Mario Dumenigo said the Navy is not sure of the size of its perchlorate problem. There are four or five known sites. Remediation efforts at McGregor seem to be working and achieving their goals.

DOE: Gerald Boyd said DOE does not know the scope of the perchlorate problem in its facilities, but there are no perchlorate problems in current facility clean-ups. There may be some issues at Los Alamos., but it does not appear that other DOE sites have significant perchlorate contamination.

SERDP: Jeff Marqusee said SERDP does a reasonably good job of preventing new perchlorate releases from major sources. However, because perchlorate is not a listed chemical, it is not a current focus of prevention activities in the field. As a result, perchlorate still is being introduced in minor amounts, particularly in distributed small sources. They need to start thinking about better ways to manage sites because perchlorate probably will become a listed chemical sometime in the future. He noted that perchlorate is not difficult to treat.

Air Force: The Air Force needs to continue current perchlorate-related activities. While communications between stakeholders are very good, they could be improved at the policy level, particularly in light of the peer review this fall and as decisions will have to be made.

DOI: Robert Wilson said the Department of Interior has not been involved in the perchlorate issue, but after listening to the morning's presentations, he will take the issue back for further investigation.

Army: The Army has had some perchlorate use in their systems but it has not been a major focus.

Mr. Kovalick observed that several agencies were attending this Roundtable meeting for the first time. He explained that Roundtable agendas usually are driven by the technology angle of a problem, but that EPA can invite appropriate personnel to future meetings if members wish to use the form to address policy issues or to talk about policies at federal facilities. He invited participants to raise policy issues they would like to address at Roundtable meetings in advance, when they receive the draft agenda, so that appropriate personnel can be invited to address these issues.

A participant said he thought the Roundtable should retain its technical focus. He suggested that the federal agencies hold a small meeting after a Roundtable meeting with the right policy staff present to discuss policy implications of selected issues.

UPDAT E ON ROUNDTABLE POLICY AND OPERATION

Cost and Performance Status Report

John Kingscott, EPA/TIO, reported on the status of the Cost and Performance initiative. This is a long-term effort to collect cost and performance data from completed clean-up projects. Each agency prepares its own studies in a standard format and these are posted on the FRTR website. The effort began in 1995 and now includes 274 cases. Fifty-six were added in the latest update and are now online. All 274 case studies are available on a CD ROM, which also includes 39 site monitoring and measurement studies and additional resources, including the FRTR screening matrix. EPA will issue a press advisory on May 31 announcing the update to trade press contacts. He asked Roundtable members to market the resource within their organizations.

The latest update includes studies on MTBE treatment, ground water treatment optimization (largely a Navy effort on pump and treat systems), in-situ flushing (DOE projects), and drycleaner sites (primarily state programs at seven small-scale cleanups). There were three Air Force multi-site efforts that dealt with monitored natural attenuation for petroleum and chlorinated hydrocarbons and with bioslurping, and an ESTCP project that dealt with attenuation of explosives. Overall, the depth of technologies has increased, and the database includes a good representation of cases studies in terms of cost and applications. The most popular case studies downloaded from the web site include: bioventing, in-situ bioremediation of ground water, chemical oxidation, phytoremediation, and the guidance for documenting case studies.

Mr. Kingscott also told participants that Volume 5 the Abstracts Report also is now available. The document includes a two-page abstract of each new project and a table of all the applications with quantities of materials treated, kinds of contaminants, and cost.

Mr. Kingscott said EPA soon will publish results of cost evaluations for selected technologies. The six technologies with the most available data include: soil vapor extraction (SVE), pump and treat, incinerator, thermal desorption, bioremediation, and permeable reactive barriers. The AFCEE evaluation for bioventing will serve as a model for application to other technologies. In response to a question, Mr. Kingscott said the cost evaluation analysis to date has shown a lot of variability. EPA is developing a consistent statistical approach that might provide some comparability data. Looking strictly at costs per amount of contaminant treated doesn't give the whole picture because there are so many variables that can affect project cost, including state of the technology, market conditions, and location. The statistical approach they are taking will not be predictive, but can be used to give overall comparisons among demonstrated technologies. He noted that in some cases, the case studies give examples where small amounts of contamination were cleaned up at a high cost. These examples can be used to caution users with similar projects about some of the variables they should consider before implementing similar remedies.

Mr. Kingscott asked participants to identify new studies by the fall Roundtable meeting so the next update effort can begin. He concluded by pointing out that the system is evolving and emphasizing the need to market the system to users. He noted that materials are available to users free of charge and data can used for a variety of purposes, including cost comparisons, meetings, and conferences. Mr. Kovalick added that FRTR members should make sure that their contractors are aware of the information in the Cost and Performance studies so that they don't do work that is already been done.

Optimization Homepage

John Kingscott told participants about a major update of the FRTR optimization homepage. This site contains a variety of optimization materials on ground water pump and treat, measurement and monitoring optimization strategies, and information on computer model simulations.

Remediation Technologies Screening Matrix Update

Richard Williams, Army Environmental Center, gave an update on the FRTR screening matrix and reference guide. The effort began in 1993 and was published as a hard-copy report with 48 technologies. Since then, the effort has evolved into a web-based system with more than 200 technologies in 64 categories. Mr. Williams reported that the web currently has over 20,000 hits a month, which translates to about 2,000 users. While U.S. contractors are the biggest users, the site is used worldwide. He said it saves site managers time and improves technology transfer.

Mr. Williams recommended updating the screening matrix and producing a third edition by expanding the technology listings, improving web site graphics, and making the matrix more user-friendly.

He outlined a proposed schedule for the update effort, as follows:

- Update each technology profile by October 2001
- Add cleanup technologies in November 2001
- Produce a final version of the update by the December 2001 FRTR general meeting

DNAPL Strategy Update

Jim Cummings, EPA/TIO, and Skip Chamberlain, DOE, provided an update of the Dense Non-Aqueous Phase Liquids (DNAPL) strategy. Mr. Cummings gave a status report on the original DNAPL initiative. He said that the initial "tool centric" technology approach of accelerating the maturation of promising in-situ DNAPL remediation technologies was unsuccessful because it lacked policy support. He said that many policy issues must be resolved before putting an emphasis on tools. He outlined a new approach that looks at current efforts of agencies with significant R&D missions (DOE, DoD, and EPA). Policy issues revolve around whether source terms can be remediated and if it makes economic sense to do so.

Mr. Cummings also summarized efforts to date for each of the four initiative areas in the original strategy: policy, demonstrations/deployments; technology transfer/outreach, and research. Policy-related efforts include:

- An EPA/TIO effort to compile empirical information on the behavior of residual plumes. If it can be shown that residual plumes will not require further treatment, a cost comparison can be made between source removal and containment pump and treat. TIO has support from the Interstate Technology Regulatory Cooperation Coalition (ITRC) in this effort.
- SERDP/ESTCP is soliciting multi-year research proposals to investigate the implications of partial source term remediation.
- EPA is sponsoring ~~a~~ an International Workshop on Source Control and Related Issues. The late-summer or early-fall workshop will be by invitation only. EPA welcomes sponsorship and participation by other agencies.
- The Army has asked the National Research Council to undertake a study of contaminant source area remediation projects and ground water plume containment systems to evaluate the effectiveness of

these actions at reducing risk and meting EPA's programmatic expectations for contaminated ground water.
- The Air Force Base Conversion Agency (AFBCA) and TIO are collaborating on efforts to better understand the true costs of remedial alternatives.

He listed several demonstrations, including the third technology demonstration at Cape Canaveral, the steam enhanced extraction pilot at Savannah River, SITE demonstration projects at Loring AFB and Edwards AFB (fractured media), a SERDP/ESTCP project to optimize hydrous pyrolysis oxidation at Beale AFB, an Air Force six-phase heating pilot at AF Plant 4, and an EPA pilot project at a wood treater.

Deployments include a steam-enhanced extraction of TCE at North Island Naval Air Station, the Yorktown Navy project to heat subsurface with steam pipes to recover fuel oil, and the Navy's in-situ oxidation projects at King's Bay and Pensacola.

Technology Transfer/Outreach efforts include an in-situ seminar series for EPA Regions and the Navy, a DOE visitor's day at Savannah River Steam Pilot, and DoD and DOE manuals on in-situ oxidation. EPA and the U.S. Army Corps of Engineers are discussing revisions to the in-situ thermal design manual.

Mr. Cummings said the issue is to decide whether it is better to continue addressing DNAPL problems on a site-by-site basis or to focus at the national level on the utility and efficacy of DNAPL source control and plume management. He suggested the topic was ideal for an FRTR subgroup.

He said that, for the short-term, a joint commitment is needed to acquire or generate data on the behavior of residual plumes. One of the FRTR agencies also needs to study current capabilities for finding DNAPLs. In the mid-term, Mr. Cummings recommended that the FRTR continue to poll agencies on strategic questions and to coordinate efforts to address the important science questions.

Skip Chamberlain gave a brief update on the Cape Canaveral project. The steam demonstration will soon begin and will be ongoing during the 2001 International Containment & Remediation Technology Conference and Exhibition in Orlando, FL. DOE also is sponsoring a follow-on workshop on sensors, and the ITRC DNAPL group plans to meet in Orlando to discuss their DNAPL "Guiding Principles" document and other policy issues.

Mr. Chamberlain then reported on the recent activities of the FRTR Work Group for Accelerating Maturation of Technologies to Remediate DNAPLs. He stated he has been working with Jackie Quinn of NASA and Jim Early to suggest a way to organize the Cooperative Interagency DNAPL effort to identify gaps in DNAPL technologies. They will put out a document outlining their proposals in the next couple of weeks. Mr. Chamberlain said he hopes to arrange a meeting in July to introduce these ideas. He displayed a proposed organization chart that had the working level effort headed by an Agency Management Team with Jackie Quinn as the lead and Tom Early as project manager responsible for overseeing and coordinating efforts in three specific areas: demonstrations and deployment, science and applied R&D, and technology transfer. He proposed a "DNAPL Central" website as part of the technology transfer effort that would act as an information exchange and lessons learned center. This might be managed by GWRTAC as a link in their ground water central.

Mr. Kovalick pointed out that Headquarters components of FRTR agencies need to be involved in this effort. They have been trying to recharacterize the approach by visiting stakeholders to see if they would like to see a new Roundtable approach. He said the Navy is doing a lot of field work in this area, but there is little interest at the Headquarters level for development of a national DNAPL strategy.

Mr. Boyd noted that DOE has a big stake in this issue and that he hopes work will continue on the DNAPL strategy. He said he supports a collaborative effort to work out significant issues. Jeff Marqusee,

DoD Environmental Security Technology Certification Program, noted the difficulty of supporting a treatment train given the degree of uncertainty about what goes on in the subsurface.

PERCHLORATE REGULATORY OVERVIEW

EPA Office of Water Regulatory Overview

Karen Wirth, EPA Office of Water, presented a regulatory overview. She explained that 1986 amendments to the Safe Drinking Water Act (SDWA) of 1974 required EPA to regulate 83 chemicals by 1989 and to prioritize and review 25 chemical contaminants every three years. The schedule proved to be too ambitious, and EPA missed these deadlines. When the SDWA was amended again in 1996, Congress narrowed the universe of universe of contaminants to be addressed and mandated a risk assessment approach.

The 1996 law requires EPA to publish a contaminant candidate list (CCL) of currently unregulated chemicals known or anticipated to occur in drinking water systems. Based on the CCL, EPA determines which chemicals to regulate in drinking water and how to focus research programs for these chemicals. EPA also uses the CCL to select chemicals for placement in the "unregulated contaminant monitoring program." Under this program, EPA can require larger water supply systems to analyze for up to 32 unregulated chemicals. Ms. Wirth said EPA started requiring monitoring for perchlorate in January 2001 and expects to have a good data set for perchlorate in drinking water by the end of 2003.

Under the SDWA, EPA must make three findings in order to regulate a chemical in the water supply:

- Does the contaminant adversely affect public health?
- Is the contaminant known or likely to occur in public wells with a frequency and at levels posing a public threat (need to show national exposure not localized)?
- Will regulation of the contaminant present a meaningful opportunity for health risk reduction?

The SDWA requires EPA to regulate any chemical for which the answer is "yes" to all three of these questions. While a regulatory determination for perchlorate is not likely in the current regulatory cycle (August 2001), EPA expects to have a reference dose for perchlorate after the peer review this fall. If the data support regulation, perchlorate will be considered in the 2003-2006 regulation cycle. In the meantime, Ms. Wirth noted that EPA's Office of Water is giving individual attention to perchlorate, even though there is no statutory requirement to do so, and that research on its occurrence is a priority. EPA probably will issue a health advisory for perchlorate that translates the RfD into a drinking water concentration on an interim basis. Health advisories are not enforceable requirements, but they allow EPA to take action by providing advice to the states and tribes. Unlike regulations, health advisories can be quickly changed if circumstances warrant.

She said EPA also is very engaged in the IPSC to ensure information exchange to support decisions. Further information is available on the perchlorate webpage: http://www.epa.gov/ogwdw/perchlor.htm.

PERCHLORATE TREATMENT TECHNOLOGIES

Interagency Perchlorate Steering Committee (IPSC)

Major Jeff Cornell, Air Force Center for Environmental Excellence, and chair of the IPSC Treatment Subcommittee, summarized activities of the IPSC. He noted that perchlorate plumes generally are very large, and the contaminant moves freely through ground water or surface water. While the substance is not difficult to treat, optimization of the systems requires work and often perchlorate is not the only problem. The treatment is potentially very expensive simply because of the volume of water treated. The DoD perchlorate treatment program is designed to provide a consistent and coordinated departmental approach to treatment technology development and deployment (TTDD). It coordinates DoD representation on perchlorate issues to the IPSC. ITRC, FRTR, and other bodies, and acts as the central

information clearinghouse for DoD and IPSC. Major Cornell emphasized that one of the most important tasks is to develop and advocate a vision of success for the TTDD. This means clarifying the difference between perceived and actual risk and showing that the problem is manageable. Gaining the public's trust is particularly important because perchlorate has a lot of drinking water implications. The key players in the program are the IPSC Treatment Technology Subcommitee, DoD Treatment Technology Working Group, water suppliers, and the private sector.

Major Cornell outlined the strategy's five major components:

- Information collection to keep abreast of TTDD activities in both public and private sector;
- Analysis aimed at identifying data gaps, redundancy, and opportunities for leveraging. Maj. Cornell said he will send to the FRTR an internal white paper on TTDD after it has gone through peer review.
- Providing advice on funding requirements to the services.
- Targeted information dissemination primarily to AF/ILE, DoD, ESOHPB, and IPSC but also to ITRC and FRTR.
- Broad information dissemination through the Defense Environmental Information Exchange (DENIX) perchlorate website, National Perchlorate Conference, and other conferences and workshops as required.

He said there may be some redundancy between the DENIX perchlorate website and what GWRTAC is developing and suggested discussing coordination between the two efforts after the meeting.

Major Cornell discussed the full-scale treatment project at the Aerojet site in Sacramento. The patented biodegradation process used there was developed to treat strategic weapons that were being decommissioned. It employs a continuous flow granular activated carbon (GAC) fluidized bed reactor (FBR) with an ethanol substrate to provide a carbon source. Nitrogen and phosphorus are added to aid in the degradation process and a sand bed polisher to remove biomass from the effluent stream. They are currently running four reactors that treat approximately 5 million gpd. The anaerobic treatment system is not effective in removing the co-contaminant TCE, but is completely effective in destroying perchlorate (~3,500 µg/l influent, <4 µg/l effluent).

Major Cornell briefly mentioned the thermal treatment system at Thiokol in Henderson, NV and the Navy's in-situ biobarrier at the Naval Weapons Industrial Reserve Plant in McGregor, TX, before describing the Baldwin Park Operable Unit Pilot Study. The treatment system at the at the Baldwin Park Operable Unit at Aerojet's Sacramento Facility was constructed to treat multiple contaminants (nitrate, perchlorate, VOCs, –nitrosodimethylamine (NDMA), and 1-4, dioxane) with the final product being potable water. The Baldwin Park pilot was designed to be large enough to demonstrate the ability to scale up to a full-size treatment plant and obtain technology approval from the state DHS to produce drinking water in the San Gabriel Basin. The design consists of the following in series: GAC/FB bioreactor, Lamella clarifier, multimedia filtration, UV/chemical oxidation, liquid-phase GAC adsorption for polishing and a disinfection unit.

The requirements for a system that is producing drinking water are somewhat different from those for a strictly remedial design. There is much more emphasis on potential pathogens, nutrient loading, and system upsets. A major part of some in-situ bioremediation efforts is the introduction of a carbon substrate, which can affect water quality. The amount of carbon substrate generally is not an issue for non-drinking water aquifers or areas far away from supply wells.

Major Cornell said that there are several viable treatment technologies for perchlorate with varying costs. This was not the case even a few years ago. However, there still are few soil treatment options, and little attention is being given to identifying soil treatment technologies.

He said AFCEE plans to sponsor at least one more national conference on perchlorate, to continue working on white papers, and plans site visits to all full-scale treatment plants. He invited FRTR members to participate in these site visits, which probably start near the end of September.

SERDP/ESTCP

Jeffrey Marqusee, ESTCP Director, discussed perchlorate research undertaken by SERDP/ESTCP. SERDP has funded several private sector and university groups to investigate the bioremediation potential for perchlorate. The researchers collected aquifer samples from sites across the country. Some of these samples were taken in clean areas. All the samples had perchlorate reducers present, including the clean sites. From this data, the investigations have shown the following:

- Perchlorate reducers are ubiquitous in subsurface environments.
- Perchlorate is used by these micro-organisms as an electron acceptor.
- A wide variety of carbon substrates can serve as electron donors.
- The reaction occurs under anaerobic conditions.

Some preliminary conclusions from the microcosm studies about site conditions indicate that:

- The choice of electron donor is site specific.
- pHs lower than 5 are inhibitory to degradation.
- Nitrate, nitrite, phosphate, and sulfate tend to be degraded before perchlorate. They are not sure what implications this might have for system design–especially when these are present in significant quantities.
- Joint reduction of sulfate is problematic at some sites.
- Co-contamination may have an effect on perchlorate degradation.

Future remediation research will include the development of a molecular probe for rapid detection of perchlorate reducers.

In response to a Congressional directive, SERDP is also supporting research in ecotoxicology. Contracts have been awarded to Texas Tech University to investigate aquatic, terrestrial, and molecular toxicology issues, and the Southern Nevada Water Authority has been asked to perform laboratory and field studies to determine the toxicological impact of on fish (carp) in Lake Mead. Oklahoma State University is studying the potential effects of ammonium perchlorate on the reproduction and development of amphibians.

Mr. Marqusee said ESTCP plans to wrap up R&D work this year and to start looking at applications. In FY02 solicitations, ESTCP is seeking in-situ abiotic and biotic technologies that specifically address the cleanup of ground water contaminated with perchlorate. They also are interested in technologies that address either aqueous phase plumes or higher strength source areas, multiple technology demonstrations, and conducting demonstrations in partnership with the services.

NASA–JPL

NASA has an Interagency Agreement with the Navy to conduct the cleanup the JPL site in Pasadena, CA. Richard Zuromski presented an update on activities at the site, which was placed on the National Priorities List in 1992, primarily because of chlorinated hydrocarbon contamination from cleaning rocket engines. Perchlorate did not become a contaminant of concern until 1997, when the site was fairly well along in its Superfund activities. There are three operable units—two dealing with ground water and one with soil.

Mr. Zuromski explained that the JPL site is in an adjudicated ground water basin, meaning all the water is a drinking water source. Drinking water purveyors in California must meet the state's interim action level of 18 µg/l for perchlorate in ground water. The interim standard can be changed when a formal MCL is adopted. If the MCL is lower than the interim standard, there will be definite treatment implications.

There is also a background issue. Several water purveyors draw water from the Colorado River and inject it into the Basin for future use. This water contains 6-9 µg/l of perchlorate. The injection area is upgradient from the JPL site and the contaminated water has now moved onto the site.

Their overall strategy is to do source reduction and plume containment to treat both perchlorate and the chlorinated hydrocarbons. They have tested three ex-situ systems at the pilot stage and hope to build on the SERDP work to do an in-situ bioremediation pilot. The systems are:

- A rotating ion exchange system developed by Calgon that regenerates the ion exchange beds as the system works. The system is cost-effective because the beds do not have to be disposed of on a regular basis. This system can easily treat perchlorate to non-detect levels while producing a waste flow of approximately 1.6 gallons for every 1,000 gallons treated. The regeneration system also treats the produced brines. However, it is energy intensive. The cost differential between treating the brines versus disposing of them off-site has closed dramatically with the rise of energy costs in California. Mr. Zuromski said that energy costs have become an important constraint on technology selection.
- A Fluidized Bed Reactor (FBR) system using native bacteria is currently being tested.
- Packed Bed Reactors are more prone to clogging than FBR, but use less energy because they do not require pumps to agitate the bed. Tests suggest that the choice of source bacteria for use in this system is not important.

Mr. Zuromski said they still several technical issues to address and explained that these technologies are seen as containment tools. There also are regulatory issues because of the presence of the drinking water aquifer. He hopes to be able to place a wall of re-injection wells for treated water around the site to prevent further plume migration. In addition to these treatment technologies, they plan to do a pilot in-situ test to treat source areas.

He concluded that while there are a number of choices to treat perchlorate, the main drivers are:

- Disposition of treated water especially a bacterial-based system.
- Cost of energy and treatment of waste streams
- Community acceptance
- Site geology
- Treatment standard

Navy

Mario Dumenigo, Naval Facilities, gave an overview of the work being performed at the Naval Weapons Industrial Reserve Plant (NWIRP), McGregor, TX. The NWIRP was originally established in 1942 by the Army as the Bluebonnet Ordnance Plant. Industrial activities at the plant included munitions and solid fuel rocket propulsion systems. It is part of the military Base Realignment and Closure (BRAC) program and was closed in 1995. The site investigation is being conducted under RARA.

Texas has applied their 22 µg/l drinking water standard for perchlorate to surface water and a 270 µg/kg soil concentration level for ground water protection. At the time of the investigation, surface water concentrations at the edge of the property were 5,600 µg/l and ground water concentrations were 91,000 µg/l. In February 1999, the Texas Natural Resources Conservation Commission (TNRCC) requested that interim measures be implemented to contain offsite migration of perchlorate. To comply, the Navy conducted a bench-scale study of five materials that might be used as the carbon substrate to biodegrade perchlorates. The objective was to design a french drain type cut-off wall that would intercept the water as well as treat it. Treated water would be held in an onsite impoundment for testing and future discharge. The wall was expected to be up to 25 feet deep and would follow the contour of the underlying weathered limestone. It would be built with gravel, overlaying reactive material, overlaying a perforated drainage pipe that would conduct the now treated water to a holding basin. Three different trenches were constructed to further evaluate the carbon substrate. To date the project has cost $10 million. The Navy calculates they have saved $3 million in capital costs by using in-situ bioremediation techniques.

EPA

Kevin Mayer said the Lawrence Livermore National Laboratory (LLNL) Site 300, which is a low flow constructed denitrifying wetlands for treating perchlorate, is working quite well. He thinks biological treatment of perchlorate contamination is the least expensive method for meeting regulatory goals. However, decision makers at several sites, including Baldwin Park and Henderson, NV, have opted for physical treatment. At Baldwin Park, there was a need for immediate action. They chose the more expensive ion exchange system over biological treatment, in part to avoid approval delays anticipated because this would have been the first site to use a biological system for a drinking water supply. He said he would have favored an in-situ system for the San Gabriel site, but Kerr McGee engineers were not comfortable with bioremediation.

Open Discussion

Ms. Dominguez said she considered the perchlorate cooperation model between agencies to be a real accomplishment. It is working well, and FRTR members should consider how to apply the cooperation model to other major problems like DNAPL. She said MTBE also would be a good candidate for bringing into this process.

There are still problems with fixing comingled plumes like perchlorate and TCE, and in some cases, the result may be treating them twice. Using anaerobic treatment for perchlorate may produce more toxic chlorinated hydrocarbon compounds (vinyl chloride).

Th cost of dealing with brines from ion exchange also is an issue. Kerr McKee in Henderson is reporting a cost of $400,000 a month for treating a 300 Gpd flow. The experience at the JPL site in California illustrates the issue of energy costs for perchlorate remediation.

NEXT STEPS

Roundtable members proposed and discussed technical and policy subjects for the next Roundtable meeting. These included: in-situ sensors, bioavailability, sediments, fractured rock, unexploded ordnance, optimization of ground water treatment systems, alternative energy resources for remediation equipment, phytoremediation (soil/ground water/alternative covers), state technology acceptance, RDF workgroup update, cost-effective solutions at small sites, emerging contaminants, and Petroleum Environmental Research Forum (PERF) update.

The group agreed that optimization of treatment systems will be the technical topic. The Air Force will chair the next meeting. The meeting adjourned.

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